Patent Application
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Temperature Measuring Device

The invention involves a temperature measuring device for measuring the temperature of a fluid that is flowing in a tube, whereby an electric temperature sensor is attached to a tube section so that it does not move radially and axially.

The designation "tube" also means tube-shaped carrying structures that have a fluid flowing through them.

From the patent US-PS 49 29 092, a resistance temperature sensor is known, which is provided for measuring the temperature of a flowing fluid in a tube section. For this purpose, the tube that is flowed through is provided with an opening which is surrounded by a flange and has a sheath projecting through it into the tube that is flowed through. The sheath contains a measurement resistor.

The relatively expensive connection using an opening in the tube that is flowed through, with an additionally welded-on flange, has proven to be problematic.

The purpose of the invention is to provide a temperature sensor for the tube that is flowed through, which consists of relatively few parts and can be brought into its measuring position at low cost. In particular, a temperature sensor for a dialysis device should be provided – as is known, for example, from the patent DE-OS 21 62 998, whereby the sensor has a tube section, the ends of which are each provided as an intake and outlet of the flowing medium.

The purpose is achieved in that the temperature sensor is mounted mechanically affixed on the outer side of the tube using a paste that conducts well thermally and electrically, whereby the temperature sensor is insulated thermally to the outside by a housing that surrounds the tube section at a distance and a connection cable that is electrically and mechanically affixed to the sensor is conducted through an opening out of the sheath-shaped housing.

It has proven to be especially advantageous that the tube section that is flowed through and is provided for measurement does not have any openings for passing through a

temperature sensor in the fluid area, so that expensive connection flanges or additional sealing measures are rendered unnecessary.

In a preferred first embodiment, the tube section that is provided with the temperature sensor is sealed off using two rings arranged coaxially to each other at a distance in a sheath-shaped housing. It has proven to be advantageous in the process that the inner space of the sheath-shaped housing insulates the sensor thermally from the surroundings so that erroneous temperature data of the sensor due to external influence is avoided. The inner space preferably has air from the surrounding atmosphere.

The temperature sensor is preferably connected to the end of the connection cable via strip conductors mounted along the tube section.

The sheath-shaped housing consists in a preferred embodiment of two semi-cylindrical parts that are connected to each other via a flexible film hinge. In the process, the film hinge has a pivoting axis that runs parallel to the tube axis. Diametrically opposite the film hinge, a sealing device is provided, which is formed through at least one bracket that catches in a recess of the opposing part of the sheath-shaped housing; preferably, two brackets are arranged at a distance along one line parallel to the longitudinal axis, which catch in corresponding recesses of the opposing part such that the connection cable is clamped between both brackets in a form-fit manner with its end in the connection area along the separation line of both parts of the sheath-shaped housing.

Thus, a relatively simple assembly is possible in an advantageous way.

Furthermore, it has proven to be advantageous that using the housing opening, a cable strain relief of the end of the connection cable can be prepared in a simple way.

Furthermore, the tube section provided with the temperature sensor is surrounded respectively by a sheath-shaped tube section in the axial direction, which has a tube connection end that is constructed as a surrounding ring and/or as a flange; an embodiment of this type is especially suited for a tube connection in dialysis devices, in which the flowing medium is conducted over large parts in flexible tubes.

In an advantageous embodiment as a tube section, a single-piece tube made of thermally good-conducting ceramic material is provided; preferably aluminum oxide is used as a ceramic. The actual temperature sensor is mounted as a surface-mounted part, whereby preferably a platinum thin-layer resistor is used as a temperature sensor in the middle area of the tube section as a SMD structural element. In the process, an inexpensive manufacturing results because of the surface mounting.

It has proven to be advantageous in the process that the mounted temperature sensor has a rapid response behavior as a result of the high thermal conductivity of the ceramic.

In the following, the object of the invention is explained in greater detail using the Figures 1a, 1b, 2 and 3;

Figure 1a shows schematically a perspective representation of the tube section in the manner of an exploded drawing.

In Figure 1b, a film hinge and bracket lock are shown in a section between the respective parts of the sheath-shaped housing which are constructed as semi-cylinders.

Figure 2 shows schematically the connection of the temperature measurement device by its tube ends at hose ends (shown broken), as they are used, for example, in a dialysis device. The connection cable is also shown broken.

Figure 3 shows, schematically in a longitudinal section, the use of a temperature measurement device in a housing of a function module, for example, a conductivity measuring device or pump device.

According to Figure 1a, a temperature sensor 2 is mounted on the outer surface of a central tube section 1 that has fluid flowing through it, and is electrically and mechanically affixed via strip conductors 3 running on the outer circumference of the tube section, to the end 5 of a connection cable that leads to the outside.

Both temperature sensor 2 as well as strip conductors 3 are, together with the ends 5 of the connection cable 4, enclosed by a sheath-shaped housing 6 that is concentrically surrounding the tube section 1 along the tube axis 10. The sheath-shaped housing 6 consists of two housing parts 6′, 6″. On the tube section 1, respective circumferential rings 7, 8 are provided for positioning of the housing 6 along the surface of the tube section, whereby the housing 6 is limited by form-fitting of its face surfaces on the rings 7, 8.

The housing 6 forms an inner atmosphere for the temperature sensor 2, whereby the air-filled inner space insulates the measurement element thermally from the surroundings. The inner space of the housing 6 is thus heated up by the fluid flowing in the tube section 11, whereby a possible heat-dissipation over the rear side of the temperature sensor is reduced.

Furthermore, the housing 6 has, in the radial direction as seen from the tube axis 10, a through-passage opening 18 for the connection cable 4, which simultaneously forms a cable strain relief by clamping of the sheath 17 of the connection cable 4.

According to Figure 1b, the housing 6 is made of two halves 6′, 6″ with the aid of a film hinge 35, whereby the halves that are joined together by it can be closed by a bracket 37 that catches in a recess 36.

The tube sections 11, 12 projecting out of the two-piece housing 6 are both provided at their end with a surrounding flange 13, 14, which is suitable for the connection of hose ends – for example, a dialysis device. The two flanges 13, 14 thus represent the hose connection ends of the tube section.

According to Fig. 2, the connection cable 4 is conducted out of the closed housing 6 through the opening 18, whereby the opening 18 simultaneously forms a cable strain relief by form-fitting, for the end 5 of the sheath 17 of the connection cable 4. Furthermore, as shown in Figure 2, each connection of hose ends 15, 16 – for example, of a dialysis device – is shown in the end area of the tube sections 11, 12, whereby the actual mounting of the hose ends is done via the respective flange 13, 14 that is not visible here (but shown in broken lines).

As shown in Figure 2, the end areas 11, 12 of the tube section 1 are thus only partially recognizable, while the flanges 13, 14 that are symbolically sketched here are covered by connection ends of tube-hoses 15, 16. An arrangement of this type is especially suitable for use in dialysis devices with a hose pump.

According to Figure 3, the tube section 1 is constructed as a middle piece of a tube-shaped carrier structure 52, which has tube flanges 55, 56 on each of its two ends, which are provided with surrounding grooves 59, 60 for receiving O-rings 57, 58. The carrier structure 52 is located in the hollow space 53 of a housing 51, for a function module, which, for example, can be a pump housing, filter housing, or conductivity measuring device, etc. The housing 51 has on its front side 54 a flange plate 64, with which a tube conduit 63 is connected to the hollow space 53 of the housing 21, whereby because of the carrier structure 52 located in it, a flowing fluid flows directly through the hollow cylindrical inner space 67 of the carrier structure. The fluid flowing through the carrier structure is then received by a hollow conduit 68 fitted to the hollow cylindrical inner space 67 within the housing 51. In order to seal off the fluid that is flowing out of the pipe conduit 63 into the carrier structure 52 and into the hollow conduit 68 from the surroundings, the O-rings 57, 58 are placed in such a way in the circumferential grooves 59, 60 so that the conduit transitions of the flowing fluid are each sealed off towards the outside. On the tube section 1 of the carrier structure 52, a temperature sensor 2 is located, which is connected to the end 69 of a connection cable 70 via strip conductors that are not shown here. The ends of the conductors 69 of the connection cable are connected through soldering to the connection areas on the conductor plate of the sensor 2.

Using the tube flange 55, 56, the carrier structure 52 is secured against shifting both in the axial direction along the tube axis 10 as well as in the radial direction perpendicularly to the tube axis 10, whereby at the same time, by flush placement of the flange plate 64 and attachment using mounting bolts 65, 66, a secure affixing of the carrier structure 52, and a sufficient sealing, using the O-rings 57, 58 located in the surrounding ring nodes, are obtained.